International Federation of Surveyors
Fédération Internationale des Géomètres
Internationale Vereinigung der Vermessungsingenieure

An Update on GNSS Issues from the International Federation of Surveyors

Matt Higgins
Chair of Commission 5 on Positioning and Measurement
International Federation of Surveyors

Outline of Presentation

- *Brief Outline of FIG*
- *Global Issues and FIG*
- *What FIG has done since last December*
- *Issues for GNSS Surveyors from Future GNSS*
- *Roles FIG Can Play*

What is FIG?

- *Federation of national associations and is the only international body that represents all surveying disciplines*
- *FIG was founded in 1878 in Paris*
- *Recognised non government organisation (NGO) by UN*
- *Over 110 countries represented in FIG*
- *Over 250,000 Surveyors around the World in the Member Associations*

The FIG Commissions

1. *Professional Standards and Practice*
2. *Professional Education*
3. *Spatial Information Management*
4. *Hydrography*
5. *Positioning and Measurement*
6. *Engineering Surveys*
7. *Cadastre and Land Management*
8. *Spatial Planning and Development*
9. *Valuation and Real Estate Management*
10. *Construction Economics and Management*
    Also Standards Network
    I represent all 10 on FIG Council for 05/06

Commission 5 Working Groups

1. *Standards, Quality Assurance and Calibration*
2. *Reference Frame in Practice*
3. *Integrated Positioning, Navigation and Mapping Systems*
4. *Cost Effective Surveying Technology and Techniques for Developing Countries (Joint with Com 3 and 7)*

Com 5 also Administers MoU with International Association of Geodesy and UN Office for Outer Space Affairs

Global Issues and FIG

- *United Nations Organizations*
  - *Habitat (MoU with FIG)*
  - *Food and Agriculture Organization (FAO) (MoU with FIG)*
  - *Committees on Spatial Data Infrastructure, eg Permanent Committee Geographic Information Infrastructure for Asia Pacific*
  - *UN OOSA (New MoU with FIG)*
- *International Standards Organization*
  - *ISO TC 211 – Geographic Information/Geomatics*
  - *ISO TC 172 – Instruments – New Work Item on testing of GPS Surveying Instruments*

Progress in 2004 on UN Action Team Issues

Progress in 2004

- FIG Working Week in Athens in May 2004
  - Takemi Chiku from UN OOSA gave a plenary session presentation.
  - In Athens, Ms Chiku also met with FIG President, Director FIG Office and me. We agreed on wording of the draft MoU between FIG and UN OOSA.
  - President of IAG presented in the same plenary session.
- The MoU between FIG and OOSA was signed at UN OOSA on 13 December 2004
  - Actions on GNSS (Coordination, Support to Action Team Projects and Education) and Disaster Management (Need to explore broader issues but GNSS User Guide is a potential immediate action)

Progress in 2004

- In my Commission we have established the Commission 5 Sub Group 5.3.3 on "GNSS Developments and Modernization"
- It sits Under Working Group 5.3 on Integrated Positioning, Navigation and Mapping Systems – Chaired by Dr. Naser El-Sheimy (Canada)
- Our goal is to present surveying users with current information regarding the international efforts being made towards the development and improvement of GNSS (i.e. GPS, GLONASS, GALILEO, JRANS and others).

Progress in 2004

- Sub-Group 5.3.3 Activities:
  - Creation of a comprehensive database of researchers involved in GNSS development/modernization
  - Exposure of current developments in the field
  - Development of a repository of relevant reference materials (including links, publications and presentations) with particular emphasis on information needed by practitioners
  - Provide a platform for the exchange of ideas and information between members and national delegates
  - Provide a discussion forum for the potential benefits in practical applications of a modernized GPS constellation, multiple and integrated satellite systems (GPS, GLONASS, GALILEO, etc).
- Input mechanism for FIG's Membership of ICG

Progress in 2004

Sub-Group 5.3.3 Chair: Larry Hothem, USGS
Vice-chair: Georgia Fotopoulos, University of Calgary
Vice-chair: Robert S. Radovanovic, SARPI Ltd.

- Chris Pikridas (Greece)
- Marcelo Santos (Canada)
- Naser El-Sheimy (Canada)
- Tomas Soler (USA)
- Joyo Agria Torres (Portugal)
- Martti Pietikäinen (Finland)
- Anna Jensen (Denmark)
- Paserio Samisoni (Fiji)
- Craig Roberts (Australia)
- Allison Kealey (Australia)
- Cedric Seynat (Australia)
- Kefei Zhang (Australia)
- Georgi Milev (Bulgaria)
- Keranka Vassileva (Bulgaria)
- William Martinez Diaz (Colombia)
- Luiz Paulo Souto Fortes (Brazil)
- Toya Nath Baral (Nepal)
- Ales Cepek (Czech Republic)
- Israel Kashani (USA)
- Pawel Wielgosz (USA)
- Joël van Cranenbroeck (Switzerland)

Progress in 2004

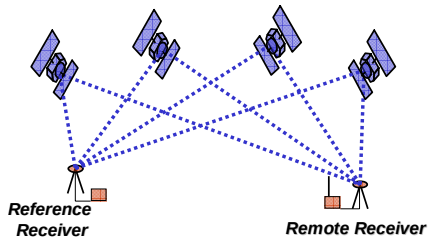
- Agreed with Chair of Commission 4 of the International Association of Geodesy (IAG) that once this FIG Sub-Group gathers momentum we will review the situation and see if it is worth making this a Joint Working Group between FIG and IAG
- That possibility is also open to our other "Sister Associations" such as:
  - International Cartographic Association or
  - International Society of Photogrammetry and Remote Sensing

GNSS Surveying

3 Levels of Accuracy from GNSS

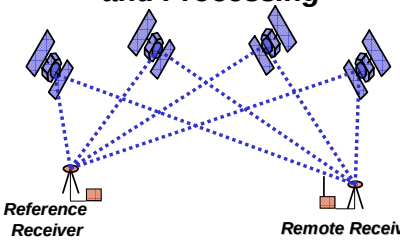
- *Single Point Positioning (metres)*
- *Differential Positioning (sub-metre)*
  - *Pseudorange Measurements*
- *GNSS Surveying (centimetre)*
  - *Carrier Phase Measurements*
  - *All of interest to FIG but this Presentation will concentrate on GNSS Surveying with Carrier Phase*

GNSS Surveying



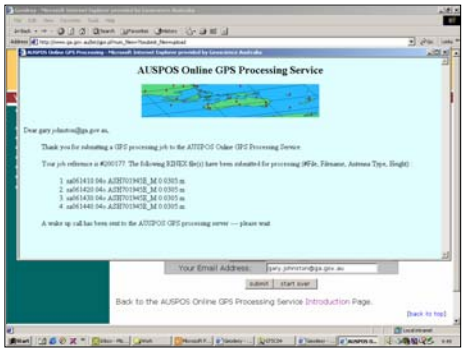
- 1985 – 4 satellites – 4 hours per day
- Observation period per new point several hours
- Data post processed

Improved Coverage, Equipment and Processing

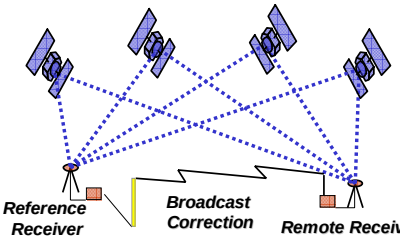


- Early 1990s - More satellites – 24 hour coverage
- Observation period per new point 10s of minutes
- Data post processed

AUSPOS Online GPS

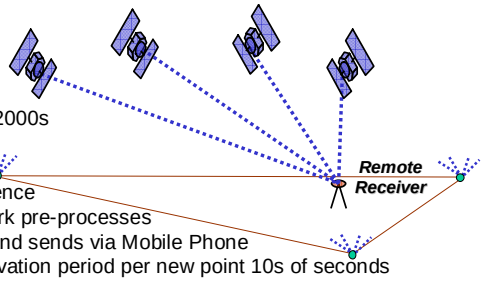


"Real Time" GNSS Surveying



- Mid-1990s – Reference Data via Radio – 5+ SVs
- Observation period per new point 10s of seconds
- Data post processed in "Real Time"
- Emergence of Receivers tracking Glonass

Networked Reference Stations



- Early 2000s
- Reference Network pre-processes Data and sends via Mobile Phone
- Observation period per new point 10s of seconds
- Data processed in Real Time
- Users work as though they are stand-alone
- Network is becoming Infrastructure

Networked Real Time Surveying

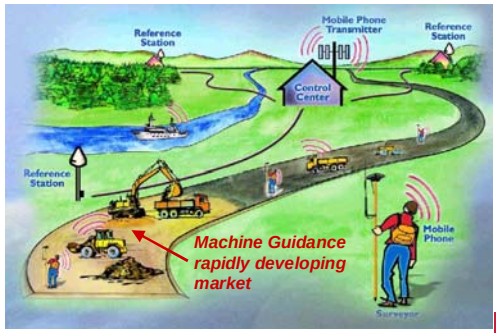


Diagram from Trimble Terrasat

Virtual Reference Station - Network Coverage

What Surveyors need from Future GNSS

Surveyors as GNSS Users

- *Surveyors small numbers but high value;*
  - *eg expensive equipment*
  - *eg working on large infrastructure projects*
- *Intelligent users at "top end" of accuracy, by squeezing high accuracy we learn a lot*
- *We can use new capabilities sooner than say transport which tends to need global coverage before adoption*
- *We are a glimpse of future users because many other users start with low accuracy and move to more accuracy*

Issues for GNSS Surveying

- *Current techniques squeeze mm from least possible amount of data, in real time, using all satellites in view and multiple frequencies but need carrier phase*
- *More Signals will give better redundancy, accuracy, efficiency and reliability (3 frequencies bring very quick initialisation)*
- *More Satellites will mean applicability in areas where masking currently occurs, eg more application in urban canyon or in open cut mining*
- *Coded Signals mean receivers will be less complicated than current codeless L2 GPS receivers and should be cheaper*
- *Cheaper centimetre capable receivers will move current "survey" techniques more towards mass market applications*

Issue - Spectrum

- *It is a shame for centimetre applications that there are not 3 common carrier frequencies on both GPS and Galileo*
- *For Surveyors the question will be… Which approach delivers the most satellites with the most frequencies at the lowest cost?*
- *So to be controversial… If Galileo has a full constellation with 3 coded frequencies by 2010 (perhaps a big IF), and GPS is still on current schedule then it is possible that:*
  - *Instead of thinking of a GPS Receiver that also measures Galileo and GLONASS*
  - *Surveyors may be thinking of a Galileo Receiver that also measures GPS (L1, L2 C and L5 as they come on line) and GLONASS*
- *So it is possible that centimetre application will switch to a Galileo emphasis sooner than some people think*
- *BUT in reality it will be more "messy" than that*
  - *That will need good information and coordination - both ICG tasks*

Issue – Reference Frame

- *Next generation GNSS will have an accuracy that requires plate tectonics to be considered:*
  - *For example Geocentric Datum Australia was fixed at 1994.0 so we already have 0.7m vs ITRF 2000 at 2004 epoch*
  - *This has prompted Omnistar (Commercial DGPS) to move their Australian "sub-metre" service from GDA94 to ITRF2000 and update at regular intervals (eg 6 monthly)*
- *This will also be an issue for Galileo's planned 0.1m accuracy commercial service*
- *FIG should work with IAG and its services (eg IERS) on this issue*

Issue - Augmentation

- *GNSS augmentation systems will become more dense for higher accuracy in certain regions*
- *More integrated with communication networks; particularly 3rd generation mobile phone systems*
- *Therefore, GNSS augmentation systems will be more transparent parts of general infrastructure*
- *It is noted that augmentations for GPS are typically supplied by a 3rd party*
- *With Galileo such augmentations can be built into its more open architecture*
- *All these points will increase the need for coordination - an important issue for ICG*

Roles FIG Can Play

Surveyors, FIG and UN GNSS

- *FIG is well placed to help with UN Action*
  - *Committed to developing country issues*
  - *National Delegates to many Commissions working in GNSS applications*
  - *Can assist with implementing and publicising reports and road maps*
  - *GNSS Education – FIG Database - over 240 institutes with 425 courses in 64 countries*
  - *Working with IAG on Reference Frame matters and helping GNSS users understand technical and policy issues*
  - *Agrees need for ICG*